

Docket # 71302

## **SUBMARINE**

### **CROSS REFERENCE TO RELATED APPLICATIONS**

[0001] This application claims the benefit of priority under 35 U.S.C. § 119 of German patent application DE 103 10 901.3-22 filed 13/March/2003 the entire contents of which are incorporated herein by reference.

### **FIELD OF THE INVENTION**

[0002] The invention relates to a submarine, and particularly to a submarine with a pressure hull and a pressure antechamber providing passage into and out of the pressure hull.

### **BACKGROUND OF THE INVENTION**

[0003] With known submarines, in particular for military application, the access into the pressure hull is effected via an entrance provided for this in the tower, and this being exclusively

above water, since water would otherwise penetrate into the pressure hull. Although further access openings are provided, according to the construction type, these however either serve for maintenance or loading purposes, or are only to be opened in the port or dock, or have a cross section which is shaped such that it is not envisaged and unsuitable for human access.

5     **[0004]**         The tasks of military submarines are also becoming more and more comprehensive, and for this reason it is desirable on the one hand to co-incorporate further installations in the submarine, be they of a military or civil nature and on the other hand to be able to discharge and take in frogmen and/or marine vessels.

10     **[0005]**         Although with military submarines it is known to outwardly transfer frogmen or scuba divers via the torpedo tubes, this however entails various risks due to the position and size (small cross section) of the torpedo tubes, which is why this solution is unacceptable for safety reasons alone. Furthermore the discharge of frogmen or divers by way of the torpedo tubes is also problematic inasmuch as these are then not available for the torpedoes, so that the performance capability of the vessel suffers.

## 15                                 BRIEF SUMMARY OF THE INVENTION

**[0006]**         Against this background it is the object of the invention to improve a submarine with regard to its possibilities of use, in particular to be able to take in and discharge frogmen in a simple manner in the submerged condition.

20     **[0007]**         According to the invention this object is accomplished by a submarine with a substantially cylindrical, elongate pressure hull which comprises at least one pressure antechamber arranged essentially transversely to a longitudinal axis of the pressure hull. The pressure

antechamber comprises an access opening to the pressure hull which is closable in a pressure-tight manner, and an access opening to an outside of the pressure hull which is closable in a pressure-tight manner. The present invention also includes a method to retrofit existing submarines to achieve these objects. A method for retrofitting a pressure antechamber in a submarine includes dividing the submarine transversely to a longitudinal axis of the submarine; and integrating a submarine section containing the pressure antechamber in-between the divided submarine. The submarine is preferably transversely divided in a region of a tower and the integrated submarine section also comprises a tower section. Advantageous formations of the invention are specified in the dependent claims, the subsequent description and the figures.

[0008] The basic concept of the present invention it to provide a submarine having an elongate pressure hull with a further pressure hull (pressure antechamber) functioning as an antechamber, and to arranged this transversely to the longitudinal axis of the pressure hull. In order to be able to carry out the antechamber function, the pressure antechamber has an access opening to the outside which may be sealed in a pressure-tight manner, as well as an access opening to the pressure hull which may likewise be sealed in a pressure-tight manner. Moreover there are provided suitable technical means in order to flood the pressure antechamber after closure of the access opening directed towards the pressure hull, and regarding pressure to adapt it to the outer pressure, as well as further in order in the reverse direction, before opening the access opening directed to the pressure hull, to bring the pressure antechamber to the atmospheric level of the pressure hull. Finally, apart from the previously mentioned means, in particular valve controls, there are yet also provided means which prevent a simultaneous opening of both access openings.

[0009] The arrangement of the pressure antechamber transverse to the longitudinal axis of the pressure hull offers the possibility of designing the access openings sufficiently large so that a person or marine vessel may pass this. The transverse arrangement requires a comparatively small installation space within the submarine. With new designs, the space required for this may be created by extending the boot design in the longitudinal direction, with existing submarines a retrofitting may be effected which, given a suitable arrangement, creates yet further free space for additional systems.

[0010] The pressure antechamber according to the invention may lie completely or partly within the pressure hull, then it passes through this at least partly, it may however also be arranged as a separate pressure hull outside the pressure hull. The pressure antechamber is then preferably arranged in the region of the tower, and specifically connecting roughly tangentially to the pressure hull so that it is connected to the pressure hull either directly (penetration through the pressure hull) or via an access tunnel. In the region of the tower there is sufficient space for such a pressure antechamber which according to the invention is arranged transversely to the longitudinal axis of the pressure hull, at least if it is the case of accommodating one or several frogmen who are to be brought in or discharged via this pressure antechamber. With this arrangement one requires no additional space within the pressure hull, it is however on the other hand still possible to accommodate the pressure antechamber within the existing outer contour of the tower so that no or only very insignificant disadvantages arise on account of this.

[0011] If the pressure antechamber is arranged within the pressure hull, then the arrangement is preferably effected in a region on which the tower is also arranged. This region is particularly favorable for this since it lies in the direct vicinity of the command center usually

arranged in the region of the tower, and permits a good communication with the command center without expensive technical installations.

5 [0012] With such an arrangement within the pressure hull, the pressure antechamber may be integrated within the pressure hull so that a part of this pressure hull, in particular the cylindrical pressure hull casing, may also simultaneously form parts of the pressure antechamber. The available space is exploited particularly well by way of this. The design however then becomes relatively heavy on account of the reinforcement which is then necessary. Thus with such an arrangement the lid for example which closes the access opening to the outside may be formed by a part of the pressure hull casing.

10 [0013] The pressure antechamber is preferably elongate and at the end comprises an access opening to the outside. With this arrangement the access opening to the outside may be formed comparatively large so that the frogman or frogmen, or the apparatus to be discharged via this may be brought out easily, or almost the whole cross section of the pressure antechamber as well as the access opening to the outside may be used.

15 [0014] With regard to design, a cylinder shape with hemispherical or flattened hemispherical end sides is suitable for an elongate pressure antechamber. In order on the one hand to exploit the space within the submarine as optimally as possible given an installation position transverse to the longitudinal axis of the pressure hull, and on the other hand to form this as lightweight as possible with regard to design, the pressure antechamber may preferably have an  
20 oval or double-ring-shaped cross section. The usable volume of the pressure antechamber may be enlarged by way of this without rendering the design excessively heavy.

[0015] An essentially rectangular cross section may be favorable with regard to the use of

space within the pressure antechamber; this however requires extensive design reinforcement in order to achieve the same pressure strength as a pressure antechamber which is round in cross section. Essentially rectangular within the context of the invention is also to be understood as a rounded rectangular cross section or one whose sides are convexly curved in cross section.

5     **[0016]**         Whilst it is favorable to provide a lid for the access opening to the outside, which frees or closes the cross section of the pressure antechamber as completely as possible, for the access opening to the pressure hull, a passage through which a frogman may crawl is usually sufficient. Should the need arise, the preparations for the diving expedition on the part of the frogman may also be carried out in the pressure antechamber itself, depending on the size of the  
10     pressure antechamber. It is also advantageous with regard to the use of space if the access opening of the pressure antechamber to the pressure hull is not arranged in an end wall but in a longitudinal wall, since then the free entry and exit may be effected in the middle of the pressure hull where there also exists adequate freedom of movement within the space of the submarine, which otherwise is quite confined.

15     **[0017]**         The pressure antechamber according to the invention is preferably designed as a decompression chamber so that one may impinge the pressure antechamber with pressure in a targeted manner in the case of diving accidents or other complications related to pressure, in order in this manner to be able to prevent formation of embolism due to the sudden release of nitrogen in blood and tissue. One thus provides a suitable control which impinges the pressure  
20     antechamber with pressure in a targeted manner and thus slowly brings this back to the normal pressure level. Furthermore, communication means are provided which permits the observation and control of vital functions of those persons located in the pressure antechamber.

**[0018]** The pressure antechamber according to the invention may also be designed for accommodating an underwater vessel so that the vessel may be brought into the pressure antechamber via suitable guides without any problem. An underwater vessel within the context of the invention at the same time is not only to be understood as an unmanned or manned mini submarine, but a water vessel in this context may also be a drive which is effective below water, with which a frogman may be propelled.

**[0019]** In order to be able to integrate the pressure antechamber according to the invention into an existing submarine, as usual there exists the lack of space. The installation would therefore always entail the extension of other units or installations. Moreover, the installation would also be rather difficult to arrange with regard to manufacturing technology since the installation into the existing pressure hull would necessitate a large-area opening of the pressure hull. The integration of the pressure antechamber into the existing pressure hull and the reclosure of the pressure hull may further more lead to unroundness in this region which significantly compromises the pressure strength. A retro-installation in the tower region is generally ruled out for reasons of space. According to the invention, for retrofitting an pressure antechamber into an existing submarine it is envisaged firstly to the divide the submarine transverse to its longitudinal axis, to pull the submarine parts apart and to integrate a premanufactured submarine section containing the pressure antechambers, i.e. to connect it to the remaining pressure hull parts in a pressure-tight and firm [rigid] manner. This method has the advantage that on the one hand the required installation space is additionally created for the pressure antechamber and on the other hand that the pressure hull is not disturbed with regard to its supporting structure, but is fastened via a peripheral seam by way of suitable welding and reinforcement on the inner side. This method

further has the advantage that the submarine section to be integrated, which contains the pressure antechamber, may be premanufactured quasi in a modular manner so that the required installations need not be assembled in a restricted space within the submarine hull but may be assembled and tested outside this. These modular submarine sections may furthermore be applied to submarines which are to be retrofitted as well as to new submarines to be designed, which reduces the manufacturing costs.

**[0020]** With this, the submarine in the region of the tower is preferably transversely divided, wherein the submarine section to be integrated also co-comprises a tower section so that it is integrated flushly into the existing outer contour in the longitudinal direction. The selection of this section in the tower region offers considerable spatial advantages since on account of this not only is the necessary installation space for the pressure antechamber created, but furthermore free space is created which may be used for further extending apparatus and for other tasks, for example for a unit for automatically accommodating water samples, for new weapons systems, sensors but also for creating additional space for the crew. Such additional components may lie in the field of communications equipment, communications reconnaissance, and opto-electrical components with extending apparatus or weapons guidance systems. The space may also be used for equipment, mines, rubber dinghies or other vessels, diving apparatus or measurement and analysis equipment.

**[0021]** The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this disclosure. For a better understanding of the invention, its operating advantages and specific objects attained by its uses, reference is made to the accompanying drawings and descriptive matter in which a preferred



embodiment of the invention is illustrated.

## BRIEF DESCRIPTION OF THE DRAWINGS

[0022] Fig. 1a is a greatly simplified schematic representation of a lateral view of a submarine according to the state of the art;

5 [0023] Fig. 1b is the submarine in a representation according to Fig. 1a, with an inserted submarine section;

[0024] Fig. 2 is a cross sectional view through a submarine in the tower region with a pressure antechamber;

10 [0025] Fig. 3 is an alternative design of the submarine in a representation according to Fig. 2; and,

[0026] Fig. 4a-d are different cross section shapes of the pressure antechamber.

## DETAILED DESCRIPTION OF THE INVENTION

[0027] The submarine 1 represented in Fig. 1a consists of an essentially cylindrical pressure hull 2 which extends almost over the whole length of the submarine 1 and which forms  
15 the pressure-tight space for the crew and apparatus. A propeller 3 as well as rudder installation 4

is formed at the stern. A tower 5 extends upwards at roughly half the length of the pressure hull 1, which in the usual manner comprises the operation and observation station for travel above water as well as further extending apparatus for travel below water.

**[0028]** With the submarine represented by way of Fig. 1a according to the state of the art, an access is only possible via the central access opening in the tower 5. In order to integrate an access antechamber into such a submarine 1 with which persons and/or apparatus may be discharged and taken in also in the submerged condition, the submarine 1 is divided transversely in the region of the tower 5. The section line is indicated at 6. After pulling the remaining halves of the submarine apart, a submarine section 7 is fitted in, which is shown crosshatched in Fig. 1b and which includes an extension of the cylindrical pressure hull 2 as well as the tower 5 arranged thereabove. The submarine section 7, which with already existing submarines 1 may be integrated by separation along the section line 6, or with submarines which are to be newly designed may be integrated from the very beginning with respect to this design, comprises a further pressure hull 9, subsequently called a pressure antechamber, arranged transversely to the longitudinal axis 8 of the pressure hull 2.

**[0029]** Two arrangements of such a pressure antechamber 9 in the form of a pressure hull 9a in the region of the tower 5 as well as a pressure hull 9b in the region below the deck 10 are shown in Fig. 3 by way of example. The pressure antechambers 9a and 9b are likewise elongate, but in the direction transverse to the longitudinal axis 8 of the pressure hull 2. At one end side (in Fig. 3 the one on the right) they comprise an access opening 11 to the outside. This access opening 11 to the outside may be closed by way of a lid 12 which is pivotally attached to the pressure antechamber 9 and which ensures a pressure-tight closure of the pressure antechamber to

the outside. With the arrangement at the top in Fig. 3, the lid 12 is covered to the outside by a casing part 13 which when the lid 12 is closed ensures that this is incorporated into the flow profile of the tower 5 in a flush manner.

[0030] A further access opening 15, and specifically to the pressure hull 2 is provided in the side walling 14 of the pressure antechamber 9a. This access opening 15 may also be closed in a pressure-tight manner by a shutter (not shown). The antechamber formed in this manner may serve for discharging or taking in a frogman 16 or a marine vessel 17, as this is illustrated by way of example in Fig. 2 and 3.

[0031] By way of the access opening 15 the frogman obtains access to the pressure antechamber 9a which at this point in time is sealingly closed with the lid 12. After closure of the access opening 15 leading to the pressure hull 2, the pressure antechamber is slowly adjusted to the outer pressure and flooded so that after opening the lid 12 the frogman 16 or the marine vessel 17 may leave the pressure antechamber 9a. The admission from the water is effected in the reverse sequence, wherein the water located in the pressure antechamber 9a is firstly blown out, whereupon the pressure is then slowly adapted to the pressure level located in the pressure hull 2 before the access opening 15 is released.

[0032] With the pressure antechamber 9b illustrated at the bottom in Fig. 3 which as the drawing shows may be designed larger below the deck 10 within the pressure hull 2 than the pressure antechamber 9a on account of the spatial arrangement, the lid 12 is movably coupled to the pressure hull section 18 which although not functionally belonging to the actual pressure hull 2 at this location however forms part of the thus formed outer contour and likewise serves for the flush closure when the lid 12 is closed. The pressure antechamber 9b also comprises an access

opening 15 in its side walling 14, but on the upper side as the illustration according to Fig. 3 indicates. The size of the pressure antechamber 9b is dimensioned such that several people may be brought in or out via this. Instead of persons one may also bring in or bring out apparatus, for example mines, location devices or likewise. If required a suitable handling device for these may be arranged within the pressure antechamber 9 in order to be able to carry out these procedures in an automatized manner, even in diving depths which are unsuitable for the exit of frogmen.

[0033] Two pressure antechambers 9a and 9b are drawn in the representation according to Fig. 3 which may be provided in the submarine section 7 alternatively, or also together. With this arrangement it is particularly advantageous that it is in the direct vicinity of the command center 19 so that the coordination of the discharging or admission procedures from and to the command center may be effected directly by the shortest path.

[0034] With the embodiment variant represented by way of Fig. 2 which likewise shows a submarine section 7, but with an alternatively equipped pressure hull 9c, part of the pressure hull 2 is designed as a separate pressure antechamber 9c, and specifically a section below the deck 10. This arrangement although offering the largest possible space for the pressure antechamber 9c however demands considerable reinforcement in the region of this pressure antechamber 9c. The access opening 11 to the outside here is formed by a pressure hull section 18 which in this case however must be designed in a pressure-resistant and impenetrable manner.

[0035] With regard to design, a pressure antechamber 9 with a round cross section is to be preferred, as is shown by way of example by way of Fig. 4b. The amount of space, as illustrated by the comparative representations of Figs. 4a to d is however comparatively low, since only the height available below the deck 10 may be exploited. Inasmuch as this is concerned the

arrangement according to Fig. 4a which shows a pressure hull with a double-ring-like cross section is more favorable, thus a pressure antechamber which is formed of two intersecting cylinder casings. On account of the shaping, this design variant needs to be additionally reinforced in contrast to that described by way of Fig. 4b. With regard to the use of space a pressure antechamber cross section of an essentially rectangular shape as described by way of Fig. 4c and 4d is even more favorable, inasmuch as these are referred to. The latter designs however necessitate a considerably greater reinforcement since they have a lower intrinsic stability on account of their shaping.

[0036] All previously described pressure antechambers 9 may also be used as decompression chambers and are designed accordingly. The arrangement of a pressure antechamber 9 in or on a submarine 1 thus opens up various application possibilities of the submarine in the military as well as civil field.

[0037] While specific embodiments of the invention have been shown and described in detail to illustrate the application of the principles of the invention, it will be understood that the invention may be embodied otherwise without departing from such principles.

## LIST OF REFERENCE NUMERALS

1	-	submarine
2	-	pressure hull
3	-	propeller
4	-	rudder installation
5	-	tower
6	-	section line
7	-	submarine section
8	-	longitudinal axis
9	-	pressure antechamber
10	-	deck
11	-	access opening to the outside
12	-	lid
13	-	casing part
14	-	side walling
15	-	access opening to the pressure hull 2
16	-	frogman
17	-	marine vessel
18	-	pressure hull section
19	-	command center
20	-	coupling location

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invented certain new and useful improvements in a SUBMARINE of which the above is a  
specification.